ENERGETICS OF SUPERSTORMS

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ABSTRACT

For the most intense storms of the space era, for which there is
good solar wind data coverage, we discuss the total energy and
power degradation during the storm development, begining at the
solar wind, then at the solar wind-magnetosphere interface
(magnetopause) and at the magnetospheric tail, ending at the two
basic inner magnetospheric dissipation regions: the ring current
and the auroral ionosphere.

It has been of key interest in Geophysics the knowledge of
magnetospheric energy consumption, especially during intervals of
enhanced geomagnetic activity (i.e. Stern, 1984; Weiss et al,
1992). Although previous studies have provided this information
for typical active periods, we try in this work to show the
results of similar studies however restricted to intervals with
very intense geomagnetic activity, namely involving very intense
magnetic storms.

Tsurutani et al (1992) reported the solar and interpl.anetary
sources for the most intense magnetic storms (superstorms) that
have occurred in the space era, for which we could find full solar
wind data coverage. The onset of those storms, with the disturbed-
time Dst index being < - 250 nT, occurred on December 19, 1980;
April 13, 1981; July 13, 1982; and September 5, 1982. It is
interesting to note what these storms occurred around the solar
maximum phase of solar cycle # 21.

Because the two main dissipation regions in the magnetosphere
are the ring current and the auroral ionosphere, we try to
quantify the energy dissipated in these regions as compared to the
associated energy sources at the solar wind, at the interaction
region between the solar wind and the magnetosphere (energy
transferred at the magnetopause) and at the magnetospheric tail.
For this purpose we use solar wind data collected by the ISEE-3
satellite at the inner Lagrangian region of the sun-earth system

, together with magnetopause, tail and ring-current energization models as well as ionospheric (NOAA) satellite measurements.

For the solar wind we compute the kinetic energy flux as the dominant energy source , For the computation of the energy transfered at the magnetopause we use the Perreault-Akasofu transfer function & modified to allow solar wind-ram pressure variability. Then for' the tail energization we use an expression discussed by Gonzalez and Mozer (1.974), representative of the pointing flux transmitted to the tail by the reconnected plasma at the dayside magnetopause , For the ring-current energization we compute the energy source as obtained from the energy balance equation commonly discussed in the literature (i.e. Gonzalez et al, 1994) . Finally, for the auroral ionospheric energization we compute the joule heating power as obtained by a hybrid method that uses satellite particle precipitation measurements (to compute the integrated ionospheric conductivity) and polar cap electric fields as mapped from the magnetopause.

For the studied superstorms it was found that about 1% to 4% of the solar wind energy source gets transmitted at the magnetopause and the tail by reconnection. Then, about 25% of this magneotspheric quantify is channeled to the ring current, whereas about one third of this latter value is dissipated as joule heating in the aurora] ionosphere. Table 1 summarizes the total energy and power associated to each of these *regions*, as average values obtained for the main phase intervals of the four studied superstorms.

TABLE 1

	POWER (WATTS) X 10^{11}	ENERGY (JOULES) X 10^{15}
Solar wind	4-/00	13500
Transferred to the magnetosphere '	80	200
Ring current	20	50
Auroral ionosphere	6	15

IMF B_S ≅ 25 ⁻30nT

Λ t ≃ 7 hours

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